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OURSELVES AND OUR BRAINS: DUALITY WITHOUT DUALISM

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THE PROBLEM of relating mental activity to brain events (and vice-versa) presents difficulties of two kinds. One difficulty is to discover and evaluate relevant empirical evidence. The other and logically prior difficulty is to discover an operationally satisfactory way of framing the questions to which we would like empirical answers. The argument of this paper is that the present confused and inconclusive debate over the 'mind/brain' problem arises largely from failures in the second category. For rationally explicable reasons, this problem presents conceptual pitfalls which have no parallel elsewhere in science; I shall argue that once these pitfalls are marked and avoided, the existing evidence fits harmoniously with what each of the traditional sides in the debate wishes to affirm, without justifying the negative conclusions supposed necessary by either side.

THE DATA

First among our data, both logically and ontologically, are the facts of our conscious experience. We see-things, hear-things, think-things, feel-things in a sequence of experiences that we would be lying to deny. It is only on the basis of specific experiences in these categories that we function as scientists and as human beings and can lay claim to scientific (or any other) knowledge about the physical world, including our brains and those of others qua physical objects. As scientists (and as ordinary people), then, we take our perceptual experiences as evidence of a massive array of facts in a different category—public facts about a world of material objects, subject to physical forces which 'cause' the succession of changes we perceive in our environment. For our present purpose I see no need to question this interpretation, despite the complications introduced by Heisenberg's Uncertainty Principle and the current revolution in our conception of subatomic matter. Because I shall be arguing that the synthesis we are looking for does not require any overthrow of classical physical theory, it will serve our purpose best to ask (for the sake of argument) what would follow if all the physical interactions in the brain and body, as well as in the environment, were governed by 'deterministic' laws of the sort that are presupposed for practical purposes in contemporary physiology and biochemistry.

What makes brain science unique, in principle, among the physical sciences is the existence of direct correlations between certain events in the physical structure of the brain and certain conscious experiences of the individual whose brain it is. While the extent of these correlations is still undemonstrated in full detail, the working assumption of most neuroscientists is that no change takes place in a human being's conscious experience

(whether of perception, belief, thought, action or whatever) without some correlated change in his cerebral state, either static or dynamic. I personally accept this working hypothesis, but my purpose now is not so much to advocate it as to spell out what would and would not necessarily follow if it were the case.

INTERACTION?

A traditional and still seriously advocated view is that if this correlation is present, it must be due to a two-way 'interaction' between mental activity and cerebral activity. For example, according to Popper, '. . . the self in a sense plays on the brain, as a pianist plays on a piano or a driver plays on the controls of a car' (Popper & Eccles, 1977, p. 495). Eccles agreed: 'The self-conscious mind acts upon . . . neural centres, modifying the dynamic spatio-temporal patterns of the neural events' (*loc. cit.*, p. 495). Sperry (1965, p. 76), though rejecting the ontological dualism of Popper and Eccles, has likewise spoken of 'an interjection into (the brain's) causal machinery of mental or conscious forces'. 'Mind and consciousness', he claimed, '. . . push and haul around the physiology and the physical and chemical processes' (*loc. cit.*, p. 78). Sperry (1980b) recently reaffirmed his view that 'the physical brain process . . . is not . . . causally complete without including the subjective mental properties . . .. Mind does actually move matter within the brain'.

It is perhaps not surprising that such statements have been read as denying the possibility-in-principle of complete causal explanations in physical or physiological terms. Indeed, Sperry himself (1980a) stated that he saw his argument as 'refuting' the 'classical physicalist assumption of a purely physical determinancy of the CNS', while Popper (*loc. cit.*, p. 541) conjectured that 'the action of the mind on the brain may consist in allowing certain fluctuations to lead to the firing of neurones'—implying that these consequences would not have followed from their physical antecedents if they had not been so 'allowed'. The presupposition behind much argumentation of this kind appears to be that if complete determination were admitted at a physiological level, this would logically rule out any possibility that human behaviour could be determined by conscious mental activity such as thinking and deciding.

In reaction to such 'interactionism', many scientists, and some philosophers, have opted for the alternative of simply (or elaborately) identifying 'mind' and 'brain', attributing all human agency to 'material' causes. Bunge (1977) distinguished between (1) 'eliminative' materialism, which would deny any reality to the mental; (2) 'reductive' materialism, which regards the mental as no different from the physical; and (3) 'emergentist' materialism (his own preference), which holds that 'mental states form a subset (albeit a very distinguished one) of brain states' (*loc. cit.*, p. 508). All varieties of materialism are united, however, in giving ultimate ontological priority to matter and its motions, rather than to mind.

A MIDDLE WAY

From the bald outline above, it might seem that we are locked into a choice between two mutually exclusive views. Much ink (some of it at high temperature) has been spilt on this assumption. But is it valid? Do we have to decide between a thought-model in which the physical chain-mesh of cause-and-effect is open to 'interactions' or 'forces' of a non-

physical kind, and one in which the primary determinant of conscious human agency is physical causation? I think not; I shall argue that this apparent 'either/or' arises from neglect of a distinction which is familiar in the down-to-earth context of information engineering.

Information engineers have learned to distinguish between two kinds or conceptual levels of 'determination': (1) of all physical processes, we can ask how force determines force, or energy determines energy, seeking answers in the domain of physical theory; (2) of some physical processes, especially in machines and living organisms, it may also make sense (and often makes more relevant sense) to ask quite a different question, namely: how does the form of this activity or state of affairs depend on the form of other activities or states of affairs? (e.g. how does the firing pattern of this cortical neurone depend on the spatio-temporal form of the retinal image?). Here we use the categories of communication and control theory (MacKay, 1951; 1969; 1978a).

The determination of force by force requires a flow of energy. The determination of form by form requires a flow of information. Of course, any flow of information in the physical world requires (is mediated by) some process involving exchange of energy, though not necessarily energy flowing in the same direction. But there is clearly no self-contradiction in saying that a given happening was determined as to its energetics by a flux of energy and as to its form by a flux of information.

This points to an option in the 'mind/body' case which would seem to obviate any need to postulate an interacting 'quasi-substantial entity', and yet would escape the materialist trap of confusing the brain with the conscious agent whose brain it is. The suggestion would be that my bodily activity depends on my conscious thinking and deciding, as the bodily activity of a goal-pursuing system depends on its calculations, for the information that specifies its form; and that it is on these grounds that I cannot escape responsibility as a conscious agent for the form that that activity takes (MacKay, 1951; 1956; 1960).

To this it could be objected that if an automaton determines the form of its bodily activity without (presumably) being a conscious agent, our suggestion might seem to throw doubt on the reality of consciousness in human beings. But this objection would quite mistake the point. In the case of an automaton we start from knowledge of its physical structure, and we impose constraints on the form of its behaviour such that we can recognize it as 'goal-pursuing'. Any human-like personality we might want to attribute to it would have to be tentatively read into the situation, and most of us would need a lot of convincing to regard it as a conscious agent. In the case of ourselves, however, the ontological boot is on the other foot. We start by knowing ourselves to be conscious agents, and as such proceed to learn about the mechanics of our brains. We know for a fact that we can make deliberate decisions and act upon them in the physical world. The purpose of the analogy with automata is thus not to persuade anyone that we are conscious, but only to dissuade anyone who might be tempted to conclude that our ability to influence physical events requires interactive interference with physical brain processes. Instead, it would seem to meet all the requirements of experience if we postulate that our conscious thinking and deciding are embodied in those brain processes, as we might say that the solving of an equation is embodied in the workings of a computer, so that it is the form of our thinking that determines the form of the physical

outcome, even while the physical energetics of our cerebral activity (within Heisenberg limits) determines its energetic aspects.

DUALITY WITHOUT DUALISM

We began by recognizing a clear duality between the immediately given facts of conscious experience on the one hand, and their presumed correlates in specific brain activities on the other. Data in the first category are available and defined only from the standpoint of the conscious agent himself. Data in the second are available in principle to outside observers of his brain processes. Elsewhere (MacKay 1960, 1973, 1978b) I have shown that in respect of the present or immediate future of the agent's brain, no completely detailed observer-specification can exist that would have an unconditional claim to the agent's assent—since the agent's assent or lack of assent would be one of the factors logically determining its correctness. This points to the first of the peculiar logical pitfalls to which I referred above. There is here an inescapable element of relativity, in that what a non-participant observer might be correct to believe about the future of the agent's brain can be something that the agent himself would be in error to believe. So, far from being a mere 'translation' of the facts of conscious experience, the observer's story about the correlated brain activities is logically complementary to them—a story about the material embodiment of that experience, valid only from the standpoint of a non-participant in the experience. The one is logically irreducible to the other, however tight the correlation between them may be (MacKay 1958, 1962, 1980a). It follows that all questions about the 'causes' of human agency must be identified for standpoint, as a matter of logical hygiene, before they are well-enough defined to be properly answered.

None of this, however, seems to require us to postulate a dualism of substance, in the sense of opening the chain-mesh of physical causality in order to make room for the causal efficacy of mental activity. Just as in a computer certain determinative information-processing operations may be embodied in identifiable local regions of hardware, and one can imagine the focus of form-determinative activity shifting around within the physical structure without any need to question the completeness of determination at the physical level, so there is plenty of room in our 'middle way' for the idea that the focus of conscious cognitive agency may be embodied in a cooperative spatio-temporal pattern of activity associated at different times and in different ways with different cerebral structures, without any need to imply that its arrival in a given region 'interjects non-physical forces' into the physical chain-mesh of the brain at that point (MacKay, 1980b).

INADEQUACY VS INCOMPLETENESS

This brings us to the second of the pitfalls to be avoided. Consider the familiar case of a microphone amplifier which develops a 'howl' because the output is allowed to feed back to the input. If we seek the cause of the howl, the relevant answer comes in terms of system properties—the gain and delay around the feedback loop, etc. To give an answer at the material level, in terms of the electric currents in each transistor or the like, would miss the relevant point, however accurate and complete the answer might be in its own categories. If, however, we were to ask for the cause of a particular physical motion of the

speaker diaphragm at a given time, an answer in material categories could be quite appropriate. The point is that it is the categorical level of our question that determines whether or not a physical explanation is adequate, yet calling the physical story inadequate does not necessarily imply that it is incomplete.

So it is, I suggest, with respect to human agency. When someone asks for the explanation of an action, our first precaution must be to identify the categorical level he has in mind. Qua neurone-firing and muscle contraction, the process may be adequately explained in purely physical terms by answering questions of the form: what made the neurons fire that made the muscles contract? Qua goal-directed selection from a human repertoire, however, it demands a complementary systemic explanation in information-engineering categories, which does not supersede or override but rather presupposes the chain-mesh of physical causation. If the action is a conscious and deliberate one, it may demand yet a higher-level explanation in terms of the agent's cognitive evaluation of his options and their costs and benefits, from his special standpoint as the conscious determinant of the outcome. Nowhere in this conceptual hierarchy are we logically justified in pitting one level of explanation against another as a rival. One level may be inadequate to express the point revealed at another, yet each may be complete (at least in principle) in its own categories.

Thus the question 'Why did he raise his arm?' is not the same question as 'What made that arm muscle contract?' The subject-category of the first is personal; that of the second is physical. It would be simply inept to answer the first exclusively in physical terms, and it would be hardly satisfactory to offer a reply to the second in personal terms. Armstrong's (1968) suggestion that 'science can give a complete account of man in purely physico-chemical terms' is dangerously ambiguous. If 'man' here means 'the physico-chemical human organism', the statement may be unexceptionable in principle, although even here the concept of 'organism' normally requires systemic rather than purely physical categories for its explication, and we have already noted that an account may be complete in its own categories while still inadequate. But if 'man' here denotes the totality of cognitive human agency as each of us knows it, any hope of giving a complete, let alone an adequate, account in purely physico-chemical terms would be as inept as it would be even in the case of a lowly computing machine. In both cases, the most complete physico-chemical story imaginable would leave unmentioned the intentional categories in terms of which a complementary explanation is demanded and, at least in the case of the computer, available.

Returning to Bunge's (1977) definition of emergentist materialism, there could be no objection on the foregoing grounds to a claim that the *brain correlates* of mental states form a subset of brain states. But to identify mental states themselves—those states of thinking, perceiving, hoping, doubting that we all know at first hand in conscious experience—with any states of the brain would be to confound categories defined from the mutually exclusive standpoints of agent and non-participant observer, respectively. That the deteminants of brain activity (qua sequence of physical states) should be wholly physical seems scientifically quite plausible. It lends no support, however, to any suggestion that the determinants of conscious human action are wholly physical.

EVIDENCE FROM PHYSIOLOGICAL PSYCHOLOGY

Our argument so far is that many pseudo-conflicts arise from a failure to respect the distinctive logic of talk about information systems, especially about information systems that talk about themselves. The existence of two different levels of determination, the physical and the informational, allows us to recognize a clear sense in which mental activity has 'causal efficacy' without denying the completeness of the causal chain-mesh at the physical level. The objection might be raised, however, that these levels are seldom as separable in human beings as they are in a digital computer. We must face the fact that major changes in conscious experience can be caused by purely physico-chemical interventions. Does this not upset the logic of the argument?

I think not, though it usefully underlines the many differences between brains and conventional digital computing machines. What it shows is that, as every information engineer recognizes, the power of form to determine form is always bounded by material constraints. If the power to an amplifier is reduced, the form of the output becomes distorted from that which the input would otherwise have determined; if an analogue computer is solving a differential equation, changes in the temperature of resistors can alter the equation being solved; and so forth. This does not abolish the categorical distinction between the computational and physical levels of causal analysis; it merely obliges us to recognize that some computational parameters may be determined more or less directly by physical ones.

By the same token, the fact that conscious moods or thoughts can be modulated by pharmacological or electrical inputs to the brain does nothing to support the idea that those moods or thoughts are 'really nothing but' physical brain states. This would be as inept as to claim that analogue computers are 'really nothing but' arrays of resistors and the like. In both cases, the implied 'either/or' is spurious. To stick to one level to the exclusion of the other would be simply to miss the facts that are there to be reckoned with at the level ignored.

The temptation to ignore this distinction may be especially strong in the field of psychotherapy. So many mental disorders now can be abated by pharmacological intervention that it might seem rational to expect to trace all such disorders eventually to biochemical malfunction. From an information engineering standpoint, however, the logic of this conclusion is dubious. In computer science, for example, we have to reckon with two quite different categories of breakdown. On the one hand, trouble can be caused by a 'hardware' fault—a blown transistor, or a weak battery, which can be put right only by physical means. More commonly, however, the programmer is plagued by what he calls 'software' faults or 'bugs in the program'. Basically this means a defect in the information-flow structure. There may be nothing physically wrong with the computer; no amount of tinkering with a soldering iron will help. The computer's 'therapist' must be prepared to use the language of the program, to set things right by what he 'instructs' the machine to do in that language.

Needless to say, brains are not digital computers, and they are doubtless more prone to 'hardware' breakdowns than their electronic counterparts; but nothing in the most completely mechanistic brain science could justify the assumption that all psychotherapy can eventually take the form of physico-chemical intervention. (To argue that speaking to

a patient is a form of physical intervention would be to miss the point. It is true only in a trivial sense, which applies equally to the typing-in of instructions to a computer, and does nothing to abolish the distinction between 'hardware' and 'software' faults.) Which categories of defect in information-flow structure can be remedied in principle by pharmacological and other forms of physical intervention, and which cannot, is an empirical question that deserves close scientific attention and cannot be settled out of hand.

What, then, of the kind of evidence cited, for example by Sir John Eccles, in support of dualist interactionism? Eccles (1981; this volume) adduces a variety of experimental pointers to the hypothesis that the voluntary calling-up of stored subroutines of learned motor actions, appropriate to any mental act of intention, is a function of the Supplementary Motor Area (SMA). He goes on to describe this as the 'liaison brain for intention', with 'reciprocity of information flow across the frontier between mind and brain' (*loc. cit.*, p. 28). While I strongly agree with his emphasis on the determinative efficacy of mental processes, I believe that this evidence of localization of selective function (taking it at its face value for the sake of argument) is at least as compatible with the more parsimonious 'middle way' we are exploring as with the dualist interactionist thought model. From the standpoint of information engineering analysis, the brain of a cognitive agent requires at least two levels of organization, one of them concerned with maintaining the vast repertoire of conditional readinesses to reckon with the field of action, and the other ('supervisory') level to be responsible for the continual ongoing adjustment of priorities and criteria of evaluation (MacKay, 1966; 1981). In an important sense, such an information system becomes its own programmer. Elsewhere (e.g. MacKay, 1966; 1981) I have argued that if the human brain indeed is organized on these lines, then the flow pattern of supervisory activity offers a natural correlate for the flux of the subject's conscious experience. If Eccles is right in locating final selection of action in the SMA, this can just as readily be interpreted to mean that the SMA embodies a key part of the self-programming supervisory information system as that the SMA is open to non-physical influences.

Eccles rightly points out (e.g. Popper & Eccles, 1977) that the multiplicity of the sensory projection areas, scattered over the cortical sheet, creates a problem for simplistic theories of mind/brain identity. He argues that the unity of conscious experience has to be 'provided by the self-conscious mind and not by the neural machinery . . .' (*loc. cit.*, p. 362). But just suppose, as our 'middle way' would suggest, that self-conscious experience is the immediate correlate of the supervisory information-flow embodied in our neural machinery. In that case its unity would depend not on the geographical proximity or homogeneity of the neural regions involved, but on the functional integration of the supervisory information-flow pattern, which can be equally tight whether those regions are scattered or juxtaposed. (Think, for example, of the unity of a process-controller which happens to use a remote computer at the end of a land-line or a satellite link.)

Other lines of evidence sometimes adduced in favour of dualist interactionism seem equally hospitable to interpretation in these more parsimonious terms. For example, Libet (1973) has reported that a short train of pulses applied to the cortex of a conscious patient

may elicit a sensation which is 'back-dated' to the time of onset, although a train of one or two pulses alone would elicit nothing. Eccles (Popper & Eccles, p. 362) infers from this that 'there can be a temporal discrepancy between neural events and the experiences of the self-conscious mind', and that 'this antedating procedure does not seem to be explicable by any neurophysiological process' (p. 364).

If we take as the correlate of conscious perception the supervisory matching response to cortical disturbance, however, a more parsimonious explanation seems possible. There is no neurophysiological difficulty in supposing that in these circumstances the corresponding time-label is computed by a backwards extrapolation from the output of the integrative process to the putative start of the stimulus. Difficulty would arise only if we assumed that the evoked cortical response measured by Libet (1973) was the only correlate of the conscious perception (MacKay, 1978a).

Kornhuber's (1974) 'readiness potential', which can be recorded from the scalp for a second or more before a voluntary movement, seems to present no difficulty for a theory that voluntary action is initiated within the supervisory system. For example, suppose that the conscious choosing of the instant at which to move a finger has as its correlate a cooperative process of cumulative interaction in the self-programming evaluative network, resulting in a gradual downward threshold-shift, or a shift of bias towards threshold, in some triggerable neural network. (A crude analogy would be the triggering process in a self-flushing toilet.) One then would expect the shift, on average, to have begun well before the eventual movement, and so to be recordable.

Finally, all sides in the debate appear to have sought to draw aid and comfort, in different ways, from the behaviour of 'split-brain' (callosotomised) patients (Sperry, 1970). Suffice it to say that, if we take the correlate of conscious choosing to be the normative activity of the supervisory system, the question whether split-brain patients have 'one free will or two' amounts to whether or not the operation has functionally split the normative supervisory level. In recent tests, though demonstrating many instances of executive goal-conflict, we (MacKay, 1981; MacKay & MacKay, 1982) have found no convincing evidence in these patients of independence at the level at which priorities can be self-modified. In any case, the facts seem at least as hospitable to the view herein outlined as to any other.

CONCLUSION

The argument of this paper has been that, if we think of our conscious mental activity as embodied in our brain activity, rather than either (a) interacting with it from another world or (b) identical with it, we can find a place for all the existing evidence without having to deny either the completeness-in-principle of physical explanations in their own categories, or the determinative efficacy of mental activity.

I agree wholeheartedly with Popper, Eccles and Sperry that nothing known to neuroscience justifies, let alone requires, the elevation of matter above mind in ontological priority—not least because we have to be conscious agents before we can learn anything about matter! I have argued here and elsewhere (MacKay, 1980b), however, that the relationship between mental activity and the neural activity in which it is embodied, like that between an equation and the computer solving it, is a more intimate one than

cause-and-effect. As a middle way between dualist interactionism and materialist monism, I would argue for what I have called 'comprehensive realism'—the view that man is a unity with logically complementary mental and physical aspects, which must be held together and reckoned with as equally real if we are to do justice to all the facts of our experience.

I also agree with Eccles, in particular, that to look for a 'seat of the mind' is not meaningless. The correlate of conscious mental activity from the information engineering standpoint, however, would not be the neural activity in a specific anatomical location so much as the informational traffic at a specific level of the cerebral information flow system—the self-programming supervisory level, responsible *inter alia* for the setting and evaluation of priorities and of criteria of evaluation. In this sense, when Popper (*loc. cit.*, p. 495) spoke of the self as 'playing on the brain . . . as a driver plays on the controls of a car, he came very close to what an information engineer could say of the normative supervisory system, though the information engineer of course would imply no objection to a purely physical explanation of its physical correlates.

In a nutshell, the 'peace formula' I have tried to spell out would describe mind as acting not on but in the brain, and conscious agency as embodied in, rather than interactive with, the special re-entrant pattern of cerebral information flow that continually and actively revises its own programme, and so becomes its own arbiter.

I am far from suggesting that we know enough to claim that such a re-entrant information flow structure is a sufficient condition of conscious experience, but I believe it is a characteristic and necessary one. Nor am I suggesting that our mental activity is only an aspect, let alone a mere subclass, of physical brain activity, as if the physical were somehow more real and fundamental. As complementary aspects of our unitary (and indeed mysterious) conscious agency, the two have equal claim to systematic study and correlation by the scientist, in the knowledge that such correlations can only enlarge the scope of our respect and compassion for one another as responsible human beings.

Note. At one or two points in this paper, I have made use of extracts from MacKay (1978a).

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